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AGRICULTURAL MEMORANDUM NO. 1026

Monitoring Rainfall for Agricultural Field Trials.

by J F Keers, Regional Agricultural Meteorologist, Midlands and Western Region.

Summary

A case is made for daily rainfall measurements to be included in agricultural field trials. The different types of rain gauge and recommended siting are presented. The standard 5 inch copper raingauge is recommended for daily measurements. The spatial variation of rainfall is briefly discussed and it is recommended that the values from one gauge are assumed to represent the rainfall over the 2 km square centred on the gauge and no larger an area.

1. Introduction

Weather conditions influence all aspects of cropping, from seedbed preparation through to harvesting. Accurate measurements of the weather parameters such as rainfall falling on the crop, the ambient air temperature and humidity, solar radiation and wind must be considered as an integral part of experimental fieldwork if useful comparisons are to be obtained between the various trials in different parts of the country or between one year and other years. Soil Moisture Deficit (SMD) is another important variable which affects trafficability and workability and hence timing of sowing, spraying, fertilising, irrigation etc., and this can be modelled for particular crops and soils given the basic meteorological data listed above.

Continuous and accurate meteorological observations are made on a rather coarse irregular network of places in the United Kingdom. This network may be dense enough for certain variables such as air temperature and wind but the natural variation of rainfall is on a much smaller spatial scale and, although the network of daily read rain gauges is relatively dense, about 4,000 in England and Wales, it is not dense enough if very localised rainstorms are to be accurately monitored. The network of raingauges is gradually being reduced as powerful weather radars measuring area rainfalls over 5km squares become operational.

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The amount of rainfall and the time of rainfall in relation to crop development and field operations may be very critical for the yield of a crop. The fertilisers, growth regulators, herbicides, etc., are very carefully monitored but very often the rainfall is not.

2. Rain Gauges

If rainfall observations at different sites are to be comparable the rain gauges should be of a standard type and the exposures of the gauges must be similar. The approved types of rain gauges are shown in Figure 1. The Met.-Office and Snowdon patterns are intended for daily recordings. The Bradford is suitable for weekly or monthly recordings in a fairly dry locality.

The octapent is a monthly gauge suitable for wetter areas such as moorlands.

The most important features of the standard gauges are:-

(a) The turned brass knife edged rim forming the apperture provides a clean cut-off for the rain.

(b) The vertical cylinder, about 4" in depth above the sloping funnel, to retain snow and hail, prevents out-splash and prevents rain being blown out by the wind as it enters the gauge.

(c) Simplicity of construction, copper does not crack or seize up in extremes of climate.

(d) The gauge is firmly fixed in the ground and can be maintained with its rim level to the ground.

(e) The fixed height of rim 30 cm (12") above the ground prevents excessive in-splashing.

(f) The bottle with narrow neck and good shoulders diminishes the loss by evaporation.

(g) The rain gauge is provided with an inner can of adequate capacity in case of the bottle becoming filled in extremely heavy rainfall.

A graduated glass measure is required for measuring the rain. It is recommended that a tapered measure, see Fig. 2, should be used as this greatly facilitates the measurement of small quantities.

3. Siting the Rain Gauge

The quantity of rain collected in a rain gauge depends to some extent upon the exposure of the gauge, so the selection of the site is important. The site should be on level ground, not on a slope or terrace and never on a wall or roof. The distance to the gauge from every object should be not less than twice the height of the object above the rim of the gauge.

A standard for trial sites of cereals, vegetables, etc., is to position the gauge in or adjacent to the trial plots well away from tall trees and buildings, with a space all around the gauge where no crops will be allowed to grow. This space should be 2m for crops which are likely to grow to a height less than 1m, eg most vegetables, 3m for cereals but for extra tall crops such as maize the space should be 4m, ie a circular area with radius 4m. The gauge should be surrounded by a gravel or shingle. A grass area is also acceptable but keeping it cut short is then an additional task. Compacted bare soil around the gauge should be avoided as this can cause in-splash in heavy rain.

4. Spatial Variability of Rainfall

The question "How many raingauges will I need to cover the area of my farm?", needs to be answered. The answer depends upon the size of the farm, the duration of rainfall, the accuracy required, and for what purpose the rainfall measurement is required. An illustrative answer is, "On occasions of widespread storm rainfall in Summer, see Table 2, there is a 10 percent chance that raingauges 5 km apart will record differences of the order 12 mm (0.5 inch approx)." Differences of this magnitude and frequency are considered too large for most agricultural field trials although for general farm use, eg irrigation scheduling, it may be acceptable.

If the trial involves crop pest or disease work then the difference between no rain and a few millimeters of rain may be important. Such differences over 5 km on the widespread storm occasions analysed in Table 2 amounted to less than one per cent of occasions, however, dry areas interspersed with wet areas are common on occasions of isolated showers and it is recommended that each trial plot includes a daily raingauge. For the investigation of some pest and disease work the intensity of the rain is important and here a continuously recording gauge should be used, with a tipping bucket or a tilting syphon mechanism.

The differences between rainfalls at 5 km spacing shown tabulated in Table 2 represents the sort of spatial rainfall distribution which occurs at some time most years and therefore should be allowed for at the planning stages of field trial work. The data shows that significant spatial variations of rainfall, 12 mm or more, have a 10 per cent chance of occurring over a distance of 5 km during widespread summer storms. Less than half this variation should be the aim for ADAS field trial purposes and it is recommended that one gauge is assumed to represent the rainfall over a 2 by 2 km area centred on the gauge with the proviso that for crop pest or disease work a smaller area may apply.

Table 2 - Frequency distribution of daily point rainfall differences (irrespective of sign) between adjacent raingauges average distance apart 5 km based on analysis of widespread storm rainfall during the Summer 1982 in Midlands to South Yorkshire area.

Event Number	Rainfall Differences (mm)					
	0-4	5-9	10-14	15-19	20-24	≥ 25
1	24	21	4	6	5	2
2	46	23	5			
3	40	14	21	4	4	
4	39	24	7	2	1	
5	31	23	16	4		
6	34	11	4			
7	21	17	10	7	6	
8	37	19	14	7	2	
9	30	19	10	1		
10	48	11	6			
11	25	23	18	7	3	
12	43	22	7	1		
13	47	23	9	1	1	
14	57	7	1			
15	44	14				
16	63	2				
TOTAL	629	273	132	40	22	2

It is of interest to note that the greatest spatial variation of daily rainfall measured over 1 km in the UK is 50 mm (2 inches) and this occurred when one of the most violent storms ever recorded in Britain remained almost stationary over North London on 14 August 1975. The storm gave 170 mm, almost 7 inches, of rain in 2½ hours at Hampstead Heath. A frequency analysis of storm rainfall shows that such a large point rainfall is likely to occur at a particular place only once in 10,000 years on average. The probability of such a large spatial variation is less than this. Such extremes can never be allowed for and a significant area around Hampstead was flooded to several feet in depth.

Any comments or suggestions relating to this paper should be addressed to the author.

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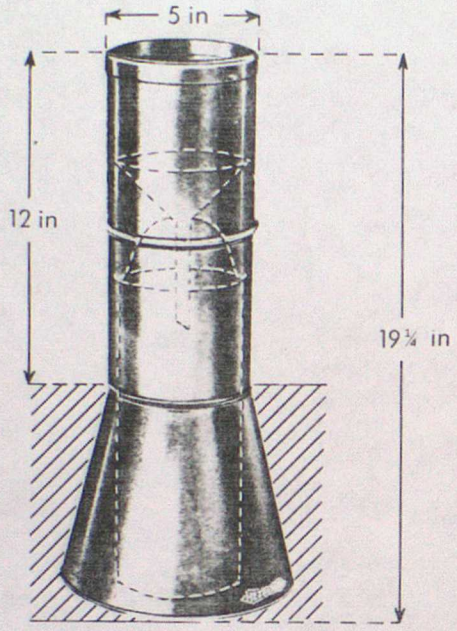
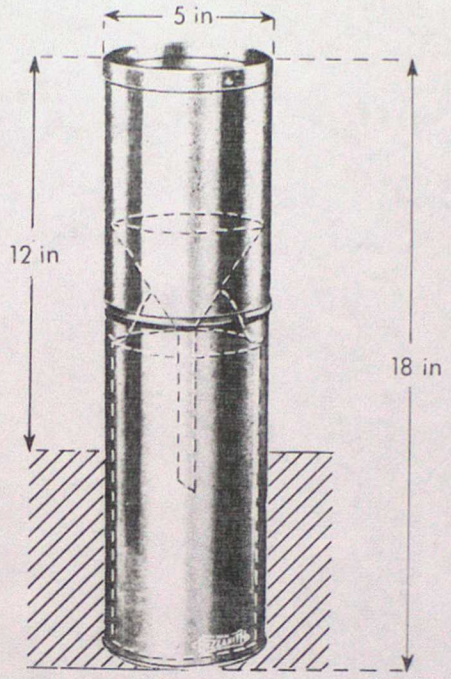
23 July 1984

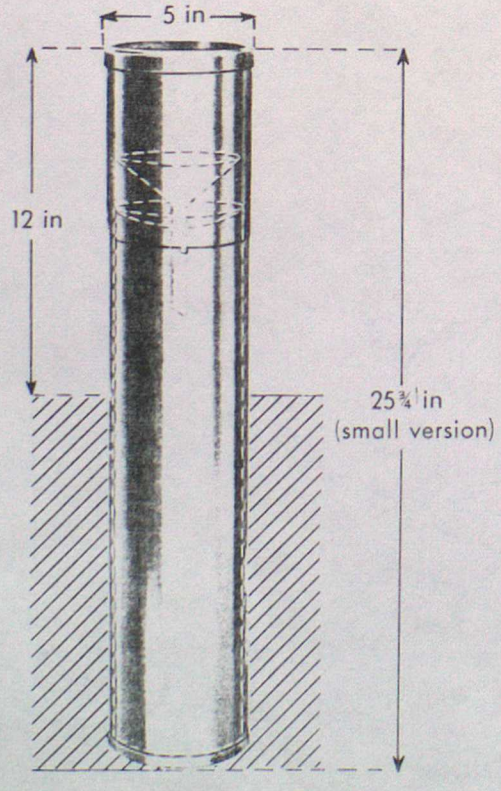
Rain-gauges



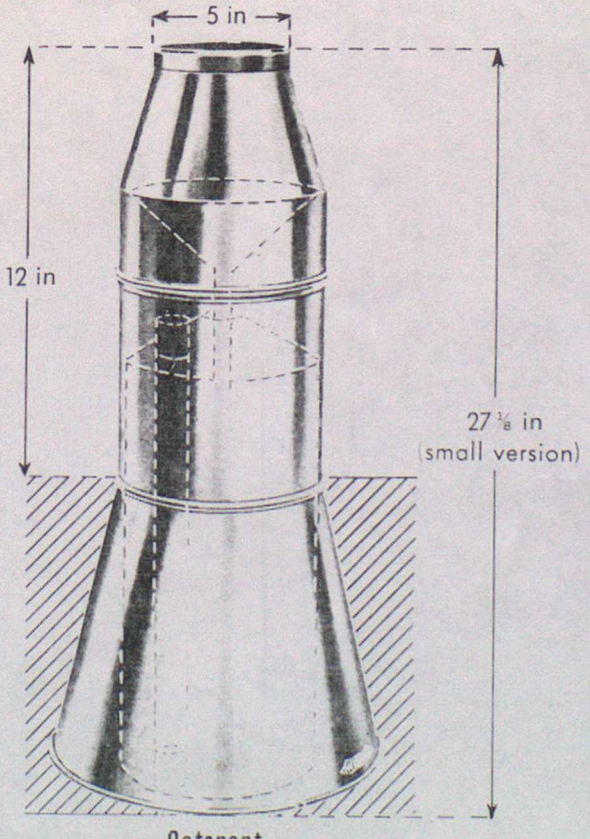
Meteorological Office Mk II



Snowdon



Bradford



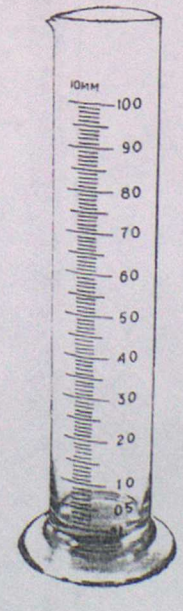
Octapent

Figure 1 APPROVED TYPES OF RAIN-GAUGES

The Meteorological Office and Snowdon patterns are intended for daily readings. The Bradford is suitable for weekly or monthly readings in a fairly dry locality. The Octapent is a monthly gauge suitable for wet areas such as moorlands.

Camden Pattern

Tapered-base Pattern



Flat-base Pattern

Figure 2 GLASS MEASURES FOR USE WITH RAIN-GAUGES

The tapered base is the pattern recommended for use with a daily gauge. The Camden is acceptable but the flat-base pattern should never be used with a daily gauge. A large 50-millimetre version is available for use with monthly gauges.